What is claimed is:

1. An olefin polymer which is a polymer of at least one olefin selected from olefins of 2 to 20 carbon atoms and has a number-average molecular weight of not less than 500 and Mw/Mn (Mw: weight-average molecular weight, Mn: number-average molecular weight) of not more than 1.5.

2. The olefin polymer as claimed in claim 1, which is polyethylene, high-density polyethylene, linear low-density polyethylene, polypropylene, polybutene, a copolymer of ethylene and at least one olefin selected from olefins of 3 to 20 carbon atoms, dienes and cycloolefins, or a copolymer of propylene and at least one olefin selected from olefins of 4 to 20 carbon atoms, dienes and cycloolefins.

3. The olefin polymer as claimed in claim 1, which is a polymer of ethylene and has a number-average molecular weight of not less than 110,000.

4. The olefin polymer as claimed in claim 1, which is a polymer of at least one olefin selected from olefins of 3 to 20 carbon atoms and has a melting point of not lower than 70°C.

5. The olefin polymer as claimed in claim 1, which is a polymer of propylene or butene and has a racemic diad (r), as measured by ^{13}C-NMR, of not less than 0.85.

6. The olefin polymer as claimed in claim 1, which is an ethylene/propylene copolymer and has an ethylene content of not less than 60 % by mol.

7. An olefin polymer which is an olefin copolymer of at least two olefins selected from olefins of 2 to 20 carbon atoms, has a number-average molecular weight of not less than 500 and is a tapered polymer containing a segment wherein composition of two or more monomers continuously changes in the polymer chain.

8. The olefin polymer as claimed in claim 7, which has Mw/Mn (Mw: weight-average molecular weight, Mn: number-average molecular weight) of not more than 2.5.

9. The olefin polymer as claimed in claim 8, which is a copolymer of ethylene and at least one olefin selected from olefins of 3 to 20 carbon atoms and has an ethylene content of not less than 30 % by mol.

10. An olefin polymer which is an olefin copolymer comprising a monomer unit M_1 derived from an olefin of 2 to 20 carbon atoms and at least one monomer unit M_2 that is different from the monomer unit M_1, and has the following properties:

$[M_1 \cdot M_2]$, $[M_1 \cdot M_1]$, $[M_2 \cdot M_2]$, $[M_1]$ and $[M_2]$, as measured by ^{13}C-NMR, satisfy the following relations:

$$1 > [M_1 \cdot M_2] / (2 \times [M_1] \times [M_2])$$

$$1 > [M_1 \cdot M_2]^2 / (4 \times [M_1 \cdot M_1] \times [M_2 \cdot M_2])$$

wherein $[M_1]$ is a molar fraction of the monomer unit M_1, $[M_2]$ is a molar fraction of the monomer unit M_2, $[M_1 \cdot M_2]$ is a molar fraction of a unit in which the monomer unit M_1 and the monomer unit M_2 are adjacent to each other, $[M_1 \cdot M_1]$ is a molar fraction of a unit in which the monomer unit M_1 and the monomer unit M_1 are adjacent to each other, and $[M_2 \cdot M_2]$ is a molar fraction of a unit in which the monomer unit M_2 and the monomer unit M_2 are adjacent to each other.

11. The olefin polymer as claimed in claim 10, which has Mw/Mn (Mw: weight-average molecular weight, Mn: number-average molecular weight) of not more than 2.5.

12. The olefin polymer as claimed in claim 11, wherein an isolated monomer unit M_1 and a sequence of two

or more consecutive monomer units M_1 are both detected in the polymer chain by means of ^{13}C-NMR.

13. The olefin polymer as claimed in claim 11, wherein a sequence of two consecutive monomer units M_1 and a sequence of three or more continuous monomer units M_1 are both detected in the polymer chain by means of ^{13}C-NMR.

14. The olefin polymer as claimed in any one of claims 11 to 13, wherein the monomer unit M_1 is an ethylene unit.

15. The olefin polymer as claimed in any one of claims 11 to 14, wherein a sequence of two or more continuous methylene groups is detected by means of ^{13}C-NMR, and a sequence of two consecutive methylene groups and a sequence of three or more consecutive methylene groups are both detected.

16. An olefin polymer which is a block copolymer comprising:

(i) a polymer block obtained from at least one olefin selected from olefins of 2 to 20 carbon atoms, and

(ii) a polymer block that is obtained from at least one olefin selected from olefins of 2 to 20 carbon atoms and is different from the polymer block (i).

17. The olefin polymer as claimed in claim 16, which comprises two or more polymer blocks, adjacent t polymer blocks of which are different from each other, and has Mw/Mn (Mw: weight-average molecular weight, Mn: number-average molecular weight) of not more than 2.5.

18. The olefin polymer as claimed in claim 17, which is a diblock copolymer comprising two polymer blocks and has Mw/Mn (Mw: weight-average molecular weight, Mn: number-average molecular weight) of less than 1.35.

19. The olefin polymer as claimed in claim 17, which is a triblock copolymer comprising three polymer blocks and has Mw/Mn of less than 1.80.

20. The olefin polymer as claimed in claim 17, which is a multiblock copolymer comprising four or more polymer blocks and has Mw/Mn of less than 2.00.

21. The olefin polymer as claimed in claim 17, wherein the polymer block is selected from polyethylene,

high-density polyethylene, linear low-density polyethylene, a copolymer of ethylene and at least one olefin selected from olefins of 3 to 20 carbon atoms, dienes and cycloolefins, atactic polypropylene, isotactic polypropylene, syndiotactic polypropylene, a copolymer of propylene and at least one olefin selected from olefins of 4 to 20 carbon atoms, dienes and cycloolefins, and the olefin polymer of claim 11.

22. The olefin polymer as claim in claim 17, which is a diblock copolymer comprising two polymer blocks selected from polyethylene, high-density polyethylene, linear low-density polyethylene, an ethylene/propylene copolymer, an ethylene/butene copolymer, an ethylene/hexene copolymer, an ethylene/octene copolymer, atactic polypropylene, syndiotactic polypropylene, a propylene/butene copolymer and a propylene/hexene copolymer.

23. The olefin polymer as claim in claim 17, which is a triblock copolymer comprising three polymer blocks selected from polyethylene, high-density polyethylene, linear low-density polyethylene, an ethylene/propylene copolymer, an ethylene/butene copolymer, an ethylene/hexene copolymer, an ethylene/octene copolymer,

atactic polypropylene, syndiotactic polypropylene, a propylene/butene copolymer and a propylene/hexene copolymer.

24. The olefin polymer as claimed in claim 17, which is a block copolymer comprising a polymer block selected from the following polymer blocks (a), (b) and (c):

(a) a polymer block obtained from ethylene,

(b) a polymer block obtained from one α-olefin selected from α-olefins of 3 to 20 carbon atoms, and

(c) a polymer block obtained from two or more α-olefins selected from α-olefins of 2 to 20 carbon atoms.

25. The olefin polymer as claimed in claim 24, which contains at least one of the polymer block (a) having a number-average molecular weight of 110,000 to 10,000,000 and Mw/Mn (Mw: weight-average molecular weight, Mn: number-average molecular weight) of not more than 1.5.

26. The olefin polymer as claimed in any one of claims 1 to 25, which has a functional group at the terminal of the main chain.

27. A molded product comprising the olefin polymer of any one of claims 1 to 26.

28. A process for preparing an olefin polymer, comprising polymerizing an olefin of 2 to 20 carbon atoms in the presence of an olefin polymerization catalyst comprising a transition metal compound which is represented by the following formula (I) and has properties that, in a β-agostic structure of a cationic complex wherein one of X in the formula (I) is replaced with a n-propyl group, said structure being measured by a density functional method, the distance between the heteroatom, which has no direct bond to the central metal M and is nearest to the central metal M, and hydrogen at the β-position is not more than 3.0 Å and the electrostatic energy is not more than 10 kJ/mol, to prepare the olefin polymer of claim 1, 7, 10 or 16;

$$L_mMX_n \qquad (I)$$

wherein M is a transition metal atom selected from Group 3 to Group 11 of the periodic table,

m is an integer of 1 to 5,

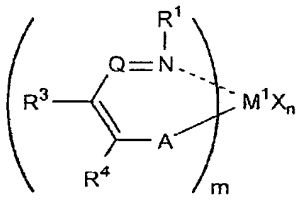
n is a number satisfying a valence of M,

L is a ligand coordinated to the central metal M and is a ligand having a heteroatom which has no direct bond to the central metal M, and

X is an oxygen atom, a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residue, a silicon-containing group, a germanium-containing group or a tin-containing group, and when n is 2 or greater, plural groups indicated by X may be the same or different, and plural groups indicated by X may be bonded to form a ring.

29. A process for preparing an olefin polymer, comprising polymerizing an olefin of 2 to 20 carbon atoms in the presence of an olefin polymerization catalyst comprising a transition metal compound which is represented by the following formula (II-a) or (II-b) and has properties that, in a β-agostic structure of a cationic complex wherein one of X in the formula (II-a) or (II-b) is replaced with a n-propyl group, said structure being measured by a density functional method, the distance between the heteroatom, which has no direct bond to the central metal M and is nearest to the central metal M, and hydrogen at the β-position is not more than 3.0 Å and the electrostatic energy is not more than 10

kJ/mol, to prepare the olefin polymer of claim 1, 7, 10 or 16;



...(II-a)

wherein M^1 is a transition metal atom selected from Group 3 to Group 11 of the periodic table,

m is an integer of 1 to 5,

Q is a nitrogen atom or a carbon atom having a substituent R^2,

A is an oxygen atom, a sulfur atom, a selenium atom or a nitrogen atom having a substituent R^5,

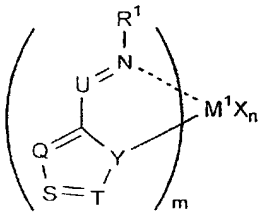
R^1 is a hydrocarbon group having one or more heteroatoms or a hydrocarbon group having one or more heteroatom-containing groups,

R^2 to R^5 may be the same or different and are each a hydrogen atom, a halogen atom, a hydrocarbon group, a hydrocarbon-substituted silyl group, an oxygen-containing group, a nitrogen-containing group, a sulfur-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residue, a silicon-containing group, a germanium-containing group or a tin-containing group, two or more of R^2 to R^5 may be

bonded to form a ring, and when m is 2 or greater, R^1s, R^2s, R^3s, R^4s and R^5s may be the same or different, and one group of R^2 to R^5 contained in one ligand and one group of R^2 to R^5 contained in other ligands may be bonded,

n is a number satisfying a valence of M^1, and

X is an oxygen atom, a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residue, a silicon-containing group, a germanium-containing group or a tin-containing group, and when n is 2 or greater, plural groups indicated by X may be the same or different, and plural groups indicated by X may be bonded to form a ring;



...(II-b)

wherein M^1 is a transition metal atom selected from Group 3 to Group 11 of the periodic table,

m is an integer of 1 to 5,

Y is a nitrogen atom or a phosphorus atom,

U is a carbon atom having a substituent R^6, a nitrogen atom or a phosphorus atom,

Q is a carbon atom having a substituent R^7, a nitrogen atom or a phosphorus atom,

S is a carbon atom having a substituent R^8, a nitrogen atom or a phosphorus atom,

T is a carbon atom having a substituent R^9, a nitrogen atom or a phosphorus atom,

R^1 is a hydrocarbon group having at least one heteroatom or a hydrocarbon group having at least one heteroatom-containing group,

R^6 to R^9 may be the same or different and are each a hydrogen atom, a halogen atom, a hydrocarbon group, a hydrocarbon-substituted silyl group, an oxygen-containing group, a nitrogen-containing group, a sulfur-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residue, a silicon-containing group, a germanium-containing group or a tin-containing group, two or more of R^6 to R^9 may be bonded to form a ring, and when m is 2 or greater, R^1s, R^6s, R^7s, R^8s and R^9s may be the same or different, and one group of R^6 to R^9 contained in one ligand and one

group of R^6 to R^9 contained in other ligands may be bonded,

n is a number satisfying a valence of M^1, and

X is an oxygen atom, a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residue, a silicon-containing group, a germanium-containing group or a tin-containing group, and when n is 2 or greater, plural groups indicated by X may be the same or different, and plural groups indicated by X may be bonded to form a ring.

30. A process for preparing an olefin polymer, comprising polymerizing an olefin of 2 to 20 carbon atoms in the presence of an olefin polymerization catalyst comprising a transition metal compound which is represented by the aforesaid formula (II-a) or (II-b) wherein R^1 is an aromatic hydrocarbon group, an aliphatic hydrocarbon group or an alicyclic hydrocarbon group, selected from a phenyl group having, at at least one position of the 2-position and the 6-position, when the position of the carbon atom bonded to nitrogen is the 1-position, one or more substituents selected from a

halogen atom and a halogen-containing group, or a phenyl group having, at at least one position of the 3-position, the 4-position and the 5-position, at least one substituent selected from a fluorine-containing group having one carbon atom and not more than two fluorine atoms, a fluorine-containing group having two or more carbon atoms, a chlorine atom, a bromine atom, an iodine atom, a chlorine-containing group, a bromine-containing group and an iodine-containing group, an aromatic hydrocarbon group other than a phenyl group having at least one substituent selected from a halogen atom and a halogen-containing group, an aliphatic hydrocarbon group having at least one substituent selected from a halogen atom and a halogen-containing group, or an alicyclic hydrocarbon group having at least one substituent selected from a halogen atom and a halogen-containing group, to prepare the olefin polymer of claim 1, 7, 10 or 16.

31. A process for preparing an olefin polymer, comprising polymerizing an olefin of 2 to 20 carbon atoms in the presence of an olefin polymerization catalyst comprising a transition metal compound which is represented by the aforesaid formula (II-a) or (II-b) wherein, when the position of the carbon atom bonded to

nitrogen is the 1-position, R^1 is a halogen-containing hydrocarbon group of 1 to 30 carbon atoms selected from a phenyl group having, at at least one position of the 2-position and the 6-position, one or more substituents selected from a halogen atom and a halogen-containing group,

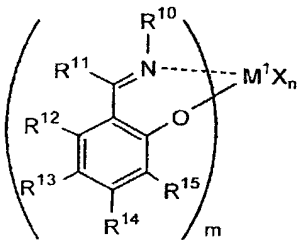
a phenyl group having, at at least one position of the 3-position, the 4-position and the 5-position, at least one substituent selected from a fluorine-containing group having one carbon atom and not more than two fluorine atoms, a fluorine-containing group having two or more carbon atoms, a chlorine atom, a bromine atom, an iodine atom, a chlorine-containing group, a bromine-containing group and an iodine-containing group,

an aromatic hydrocarbon group other than a phenyl group having at least one substituent selected from a halogen atom and a halogen-containing group,

an aliphatic hydrocarbon group having at least one substituent selected from a halogen atom and a halogen-containing group,

and an alicyclic hydrocarbon group having at least one substituent selected from a halogen atom and a halogen-containing group, to prepare the olefin polymer of claim 1, 7, 10 or 16.

32. A process for preparing an olefin polymer, comprising polymerizing an olefin of 2 to 20 carbon atoms in the presence of an olefin polymerization catalyst comprising a transition metal compound which is represented by the following formula (III), to prepare the olefin polymer of claim 1, 7, 10 or 16;



...(III)

wherein M^1 is a transition metal atom selected from Group 4 to Group 5 of the periodic table,

m is 1 or 2,

R^{10} is an aromatic hydrocarbon group, an aliphatic hydrocarbon group or an alicyclic hydrocarbon group, when R^{10} is a phenyl group and the position of the carbon atom bonded to nitrogen is the 1-position, this phenyl group has, at at least one position of the 2-position and the 6-position, one or more substituents selected from a heteroatom and a heteroatom-containing group, or has, at at least one position of the 3-position, the 4-position and the 5-position, at least one substituent selected from a heteroatom other than a fluorine atom, a fluorine-

containing group having one carbon atom and not more than two fluorine atoms, a fluorine-containing group having two or more carbon atoms, and a group containing a heteroatom other than a fluorine atom, and when R^{10} is an aromatic hydrocarbon group other than a phenyl group, an aliphatic hydrocarbon group or an alicyclic group, this group has at least one substituent selected from a heteroatom and a heteroatom-containing group,

R^{11} to R^{14} may be the same or different and are each a hydrogen atom, a halogen atom, a halogen-containing group, a hydrocarbon group, a hydrocarbon-substituted silyl group, an oxygen-containing group, a nitrogen-containing group or a sulfur-containing group,

R^{15} is a halogen atom, a halogen-containing group, a hydrocarbon group or a hydrocarbon-substituted silyl group,

n is a number satisfying a valence of M, and

X is an oxygen atom, a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residue, a silicon-containing group, a germanium-containing group or a tin-containing group, and when n is 2 or greater, plural groups

indicated by X may be the same or different, and plural groups indicated by X may be bonded to form a ring.

33. The process for preparing an olefin polymer as claimed in claim 32, wherein the transition metal compound is a compound of the aforesaid formula (III) wherein, when the position of the carbon atom bonded to nitrogen is the 1-position, R^{10} is a halogen-containing hydrocarbon group of 1 to 30 carbon atoms selected from a phenyl group having, at at least one position of the 2-position and the 6-position, one or more substituents selected from a halogen atom and a halogen-containing group, a phenyl group having, at at least one position of the 3-position, the 4-position and the 5-position, at least one substituent selected from a fluorine-containing group having one carbon atom and not more than two fluorine atoms, a fluorine-containing group having two or more carbon atoms, a chlorine atom, a bromine atom, an iodine atom, a chlorine-containing group, a bromine-containing group and an iodine-containing group, an aromatic hydrocarbon group other than a phenyl group having at least one substituent selected from a halogen atom and a halogen-containing group, an aliphatic hydrocarbon group having at least one substituent selected from a halogen atom and a halogen-containing

group, and an alicyclic hydrocarbon group having at least one substituent selected from a halogen atom and a halogen-containing group.

34. A process for preparing an olefin polymer, comprising polymerizing an olefin of 2 to 20 carbon atoms in the presence of an olefin polymerization catalyst comprising the transition metal compound of claim 32, to prepare the olefin polymer of claim 7, 10 or 16.

35. A process for preparing an olefin polymer, comprising polymerizing an olefin of 2 to 20 carbon atoms in the presence of an olefin polymerization catalyst comprising the transition metal compound of any one of claims 28 to 34 to prepare a polymer and then bringing the polymer into contact with a functional group-containing compound to prepare an olefin polymer having a functional group at the terminal.

36. A process for preparing an olefin polymer, comprising polymerizing at least two olefins which are selected from olefins of 2 to 20 carbon atoms and have different polymerization reactivities, in the presence of an olefin polymerization catalyst comprising the transition metal compound of any one of claims 28 to 34

to prepare a tapered polymer containing a segment wherein composition of two or more monomers continuously changes.

37. A process for preparing an olefin polymer, comprising conducting the following step (1), the following step (2), and optionally, the following step (3) of an arbitrary number of times, to prepare a block copolymer having a structure wherein plural polymer blocks are bonded;

(1) a step of polymerizing at least one olefin selected from olefins of 2 to 20 carbon atoms in the presence of an olefin polymerization catalyst comprising the transition metal compound of any one of claims 28 to 34 to prepare a polymer block,

(2) a step of polymerizing at least one olefin selected from olefins of 2 to 20 carbon atoms in the presence of the polymer block prepared in the step (1) to prepare a polymer block which is different from the polymer block prepared in the step (1), and

(3) a step of polymerizing at least one olefin selected from olefins of 2 to 20 carbon atoms in the presence of the polymer block prepared in the step (1) and the polymer block prepared in the step (2) to prepare a polymer block which is different from the polymer blocks prepared in the previous step.

38. A process for preparing an olefin polymer, comprising preparing a tapered polymer or an olefin block copolymer by the process of claim 36 or 37 and then bringing the (co)polymer into contact with a functional group-containing compound to prepare a tapered polymer or an olefin block copolymer having a functional group at the terminal.

39. A process for preparing an olefin polymer, comprising polymerizing an olefin in the presence of a polymerization catalyst which promotes living polymerization of an olefin and further conducting olefin polymerization by the use of a catalyst obtained by cleaving a bond produced in the system between the catalyst and the resulting polymer chain by means of chain transfer reaction.

40. The process for preparing an olefin polymer as claimed in claim 39, wherein the chain transfer reaction is promoted by the use of at least one compound selected from hydrogen, an organoaluminum compound, an organoboron compound, an organozinc compound, an organosilicon compound, an organocadmium compound and an organolead compound.

41. The process for preparing an olefin polymer as claimed in claim 39 or 40, wherein the olefin polymerization catalyst is the catalyst of any one of claims 28 to 34.

42. The process for preparing an olefin polymer as claimed in claim 39 or 40, wherein the olefin polymerization catalyst is the catalyst of any one of claims 28 to 34, and the olefin polymer, the tapered polymer or the olefin block copolymer of claim 1, 7, 10 or 16 is prepared.

43. The process for preparing an olefin polymer as claimed in claim 39, wherein at least one polymer of the olefin polymer obtained before the chain transfer reaction and the olefin polymer obtained after the chain transfer reaction is the tapered polymer or the olefin block copolymer of claim 7, 10 or 16.

44. The process for preparing an olefin polymer as claimed in claim 39, wherein the olefin polymer obtained before the chain transfer reaction and the olefin polymer obtained after the chain transfer reaction are each the

tapered polymer or the olefin block copolymer of claim 7, 10 or 16.